

We Claim:

1. An hydraulic cylinder comprising:  
a sleeve cylinder, stationary between extended and retracted positions, for  
5 substantially defining a second hydraulic fluid chamber;  
an internal cylinder, substantially retained within the sleeve cylinder, for  
substantially defining a first hydraulic fluid chamber;  
wherein the internal cylinder is adapted to be displaced to the extended  
position to deliver a power stroke upon filling either the first or second hydraulic  
10 chambers with hydraulic fluid.
2. The hydraulic cylinder of claim 1 further comprising:  
a piston having a piston rod, substantially retained within the sleeve  
cylinder, and a piston cap, substantially retained within the internal cylinder;  
15 an inner portion, substantially defined between the piston cap and an  
internal cylinder piston rod gland, and adapted to displace the sleeve and internal cylinder  
to the retracted position upon being filled with hydraulic fluid, to thereby deliver a  
second power stroke.
- 20 3. The hydraulic cylinder of claim 2 further comprising:  
a first fluid connection for hydraulically connecting to the first and second  
chambers; and

a second fluid connection for hydraulically connecting to the inner  
portion;

an hydraulic system for alternately pressurizing one of the first and second  
fluid connections while venting the respective other of the first and second fluid  
5 connections, so as to effect displacement of the internal cylinder between the extended  
position and the retracted position.

4. The hydraulic cylinder of claim 3 wherein the hydraulic system  
comprises:

10 an hydraulic pump for pressurizing the respective fluid connections;  
a fluid reservoir for venting the respective fluid connections; and  
an hydraulic valve for respectively switching the respective fluid connections  
between the pump and the tank.

15 5. The hydraulic cylinder of claim 4 wherein the hydraulic valve further  
comprises:

a first operative position for connecting the first fluid connection to the hydraulic  
pump and the second fluid connection to the fluid reservoir; and  
a second operative position for connecting the first fluid connection to fluid  
20 reservoir and the second fluid connection to the hydraulic pump.

6. The hydraulic cylinder of claim 3 wherein the first fluid connection  
comprises a sequence valve including an operative state for detecting a predetermined

pressure in the first chamber and, upon detecting the predetermined pressure, opening the valve to pressurize the second chamber.

7. The hydraulic cylinder of claim 1 wherein the sleeve cylinder includes a  
5 base in operative contact with a machine component, reciprocally to drive the internal cylinder.

8. A method of hydraulic operation comprising:  
providing a hydraulic cylinder having first and second chambers and an  
10 inner portion;  
pressurizing the first and second chambers so as to displace the hydraulic cylinder to an extended position, and thereby deliver a first power stroke;  
pressurizing the inner portion so as discharge the first and second  
chambers and displace the cylinder to a retracted position, and thereby deliver a second  
15 power stroke;  
repeating the steps of pressurizing the first and second chambers and  
pressurizing the inner portion, wherein the step of pressurizing the first and second  
chambers further comprises discharging the inner portion.

20 9. The method of claim 8 wherein:  
the step of pressurizing the first and second chambers comprises a step of hydraulically connecting the first and second chambers through a first fluid connection;  
and

the step of pressurizing the inner portion comprises a step of hydraulically connecting the inner portion through a second fluid connection; and

alternately pressurizing one of the first and second fluid connections while venting the respective other of the first and second fluid connections, so as to effect displacement of the internal cylinder between the extended position and the retracted position.

10. The method of claim 9 wherein the step of pressurizing the first and second chambers comprises:

10                   pressurizing the first chamber with a hydraulic pump;  
                      creating a negative pressure in the second chamber to draw in fluid from a fluid reservoir;  
                      detecting a predetermined pressure in the first chamber;  
                      upon reaching the predetermined pressure, pressurizing the second  
15   chamber by connecting the second chamber to the hydraulic pump.

11. An hydraulic system comprising:

                      a base in operative contact with a machine component, for delivering mechanical power to the machine component;  
20                   an hydraulic cylinder for reciprocally driving the machine component , the hydraulic cylinder comprising:

a sleeve cylinder, in mechanical contact with the base, and stationary between extended and retracted positions, for substantially defining a second hydraulic fluid chamber;

5 an internal cylinder, substantially retained within the sleeve cylinder, for substantially defining a first hydraulic fluid chamber;

a piston having a piston rod, substantially retained within the sleeve cylinder, and a piston cap, substantially retained within the internal cylinder;

an inner portion, substantially defined between the piston cap and an interior portion of the internal cylinder;

10 wherein the internal cylinder is adapted to be displaced to the extended position to deliver a first power stroke upon pressurizing the first and second hydraulic chambers with hydraulic fluid; and

wherein the inner portion is adapted to displace the sleeve cylinder and internal cylinder to the retracted position upon being pressurized with hydraulic fluid,  
15 to thereby deliver a second power stroke.

12. The hydraulic system of claim 11 further comprising:

a first fluid connection for hydraulically connecting to the first and second chambers; and

20 a second fluid connection for hydraulically connecting to the inner portion;

an hydraulic system for alternately pressurizing one of the first and second fluid connections while venting the respective other of the first and second fluid

connections, so as to effect displacement of the sleeve cylinder between the extended position and the retracted position.

13. The hydraulic system of claim 12 wherein the hydraulic system  
5 comprises:  
an hydraulic pump for pressurizing the respective fluid connections;  
a fluid reservoir for venting the respective fluid connections; and  
an hydraulic valve for respectively switching the respective fluid connections  
between the pump and the tank.

10

14. The hydraulic system of claim 13 wherein the hydraulic valve further  
comprises:

a first operative position for connecting the first fluid connection to the hydraulic  
pump and the second fluid connection to the fluid reservoir; and

15 a second operative position for connecting the first fluid connection to fluid  
reservoir and the second fluid connection to the hydraulic pump.

15. The hydraulic system of claim 12 wherein the first fluid connection  
comprises a sequence valve including:

20 a first operative state for pressurizing the first chamber and creating a  
negative pressure in the second chamber to draw in fluid; and

a second operative state for detecting a predetermined pressure in the first chamber and, upon detecting the predetermined pressure, opening the valve to pressurize the second chamber.

5           16.     The hydraulic system of claim 12 wherein the first fluid connection comprises a valving system for selectively pressurizing at least one of the first and second chambers, so as to provide a variable force hydraulic cylinder.

10           17.     The hydraulic system of claim 16 wherein the valving system comprises a four-way valve that can be selectively actuated to respectively admit pressurized fluid to one of the first and second fluid lines and to admit return flow from the respective other of the first and second fluid lines.

15           18.     The hydraulic system of claim 17 wherein the valving system further comprises a two-way valve in the first fluid line for admitting pressurized fluid into the first fluid chamber in a first speed mode, for displacing internal cylinder, thereby creating a negative pressure in the second chamber for opening a first check valve and passively drawing fluid thereinto.

20           19.     The hydraulic system of claim 18 wherein the valving system further comprises a sequence valve in the first fluid line for sensing a first predetermined system pressure and opening to admit pressurized fluid to the second fluid chamber while closing

the two-way valve in the first speed mode, for transferring fluid to the second chamber.  
To create a second speed mode.

20. The hydraulic system of claim 19 wherein the valving system further  
5 comprises a second sequence valve in the first fluid line for sensing a second  
predetermined system pressure and opening to admit pressurized fluid to both the first  
and second fluid chambers in a third speed mode.

21. The hydraulic system of claim 11 wherein:  
10 the sleeve cylinder further comprises a sleeve cylinder open end for  
receiving the internal cylinder, and a sleeve cylinder closed end for affixing an  
attachment end of the piston rod, opposite from the piston cap;  
the internal cylinder further comprises an internal cylinder closed end and  
an internal cylinder open end for receiving the piston cap, further comprising a cylinder  
15 seal for enclosing the internal cylinder open end, wherein the seal includes an aperture for  
admitting the piston rod;  
wherein the volume enclosed by the sleeve cylinder, the sleeve cylinder  
closed end and the cylinder seal defines the second hydraulic fluid chamber;  
wherein the volume enclosed by the internal cylinder closed end and the  
20 piston cap defines the first hydraulic fluid chamber; and  
wherein the volume enclosed by the cylinder seal and the piston cap  
defines the inner portion.



22. The hydraulic system of claim 21 further comprising a second hydraulic fluid chamber port for admitting hydraulic fluid, formed in one of the sleeve cylinder and the sleeve cylinder closed end.

5 23. The hydraulic system of claim 21 further comprising a first hydraulic fluid chamber port for admitting hydraulic fluid, formed in one of the internal cylinder near the internal cylinder closed end, and a fluid passage formed through the piston rod.

24. The hydraulic system of claim 21 further comprising an inner portion port  
10 for admitting hydraulic fluid, formed in a fluid passage formed through the piston rod.

25. The hydraulic system of claim 21 further comprising:  
a shaft seal retained near the sleeve cylinder open end for providing a fluid seal with the internal cylinder;  
15 a inner portion port for admitting hydraulic fluid, formed in the sleeve cylinder near the shaft seal; and  
a second inner portion port for admitting hydraulic fluid, formed in the internal cylinder near the cylinder seal.

20